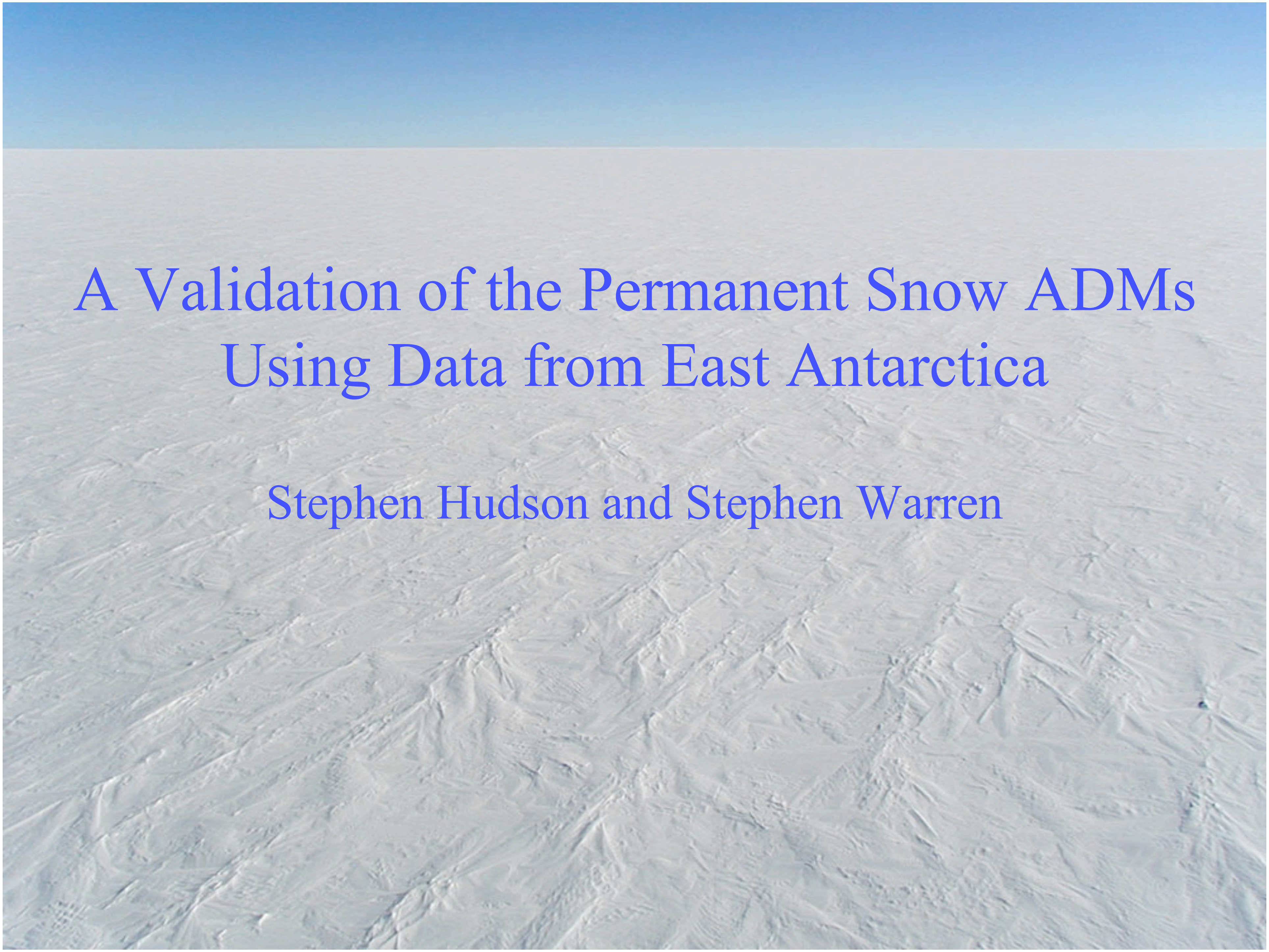
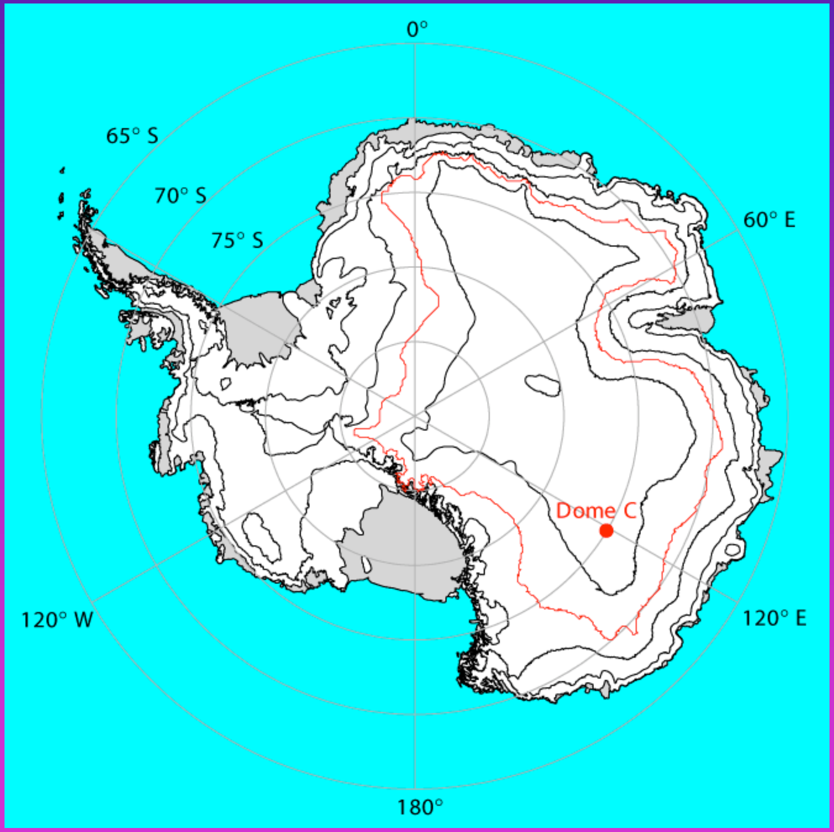


A Validation of the Permanent Snow ADMs Using Data from East Antarctica

Stephen Hudson and Stephen Warren

Observations and Parameterization

- We made spectral observations of the anisotropic reflectance factor (*R*) of the snow at Dome C
  - λ 350—2400 nm
  - θ_o 52—87°
- Using these, we developed a parameterization for *R*



75°S, 123°E, 3250 m

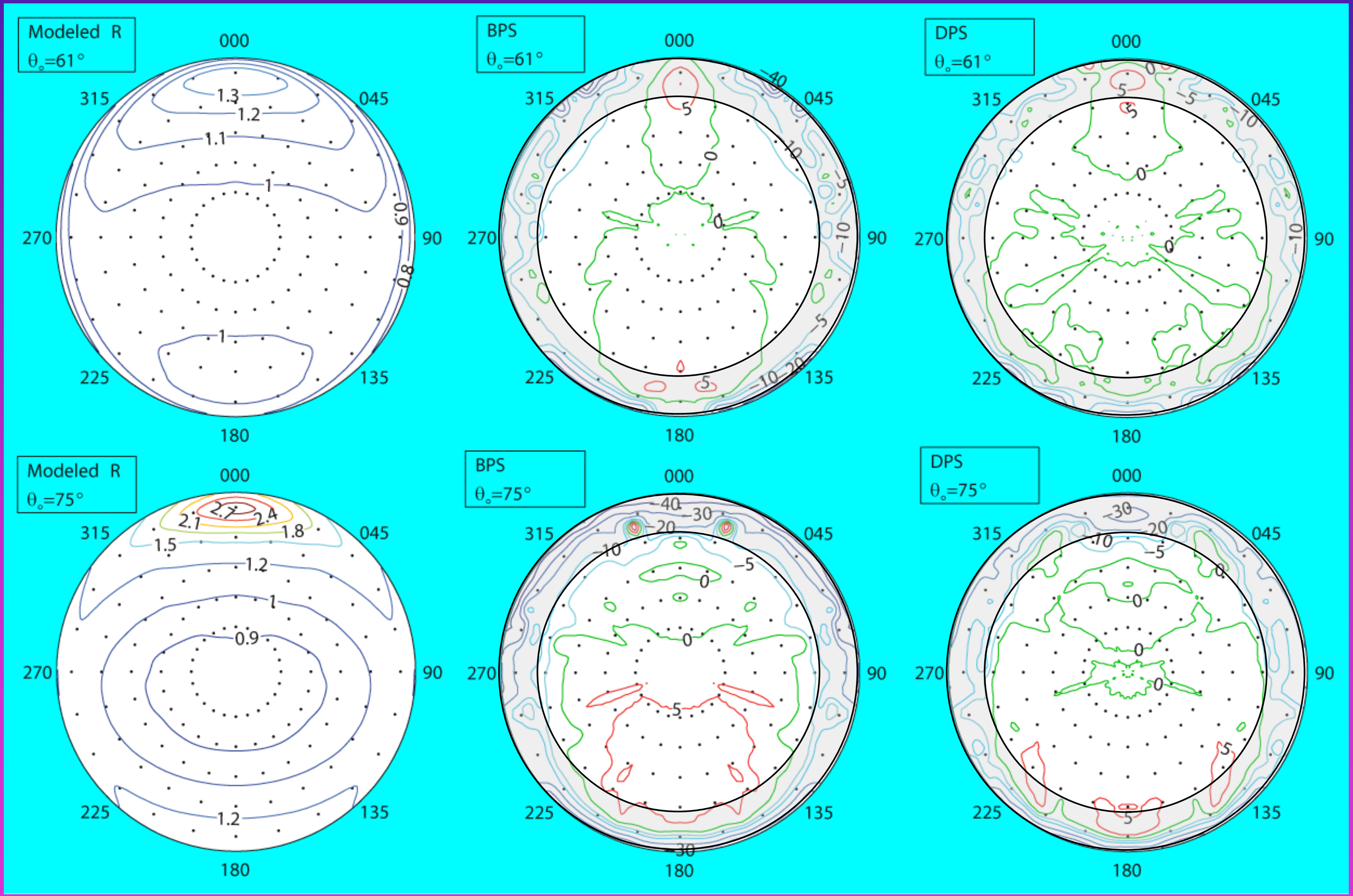
Observations and Parameterization

The observations were made with a 15° field of view from 32 m above the surface to capture the effects of the snow-surface roughness

Modelling TOA Reflectance

- The parameterization was used as the lower boundary in SBDART (DISORT), which was used to calculate TOA radiance and flux
- The atmospheric profile was the mean of 47 radiosoundings made at Dome C during January 2004, along with NOAA ozonesonde data from South Pole
- Results were integrated from 0.2 to 10 μm for comparison with CERES shortwave channel

Comparing CERES and Modeled ADMs

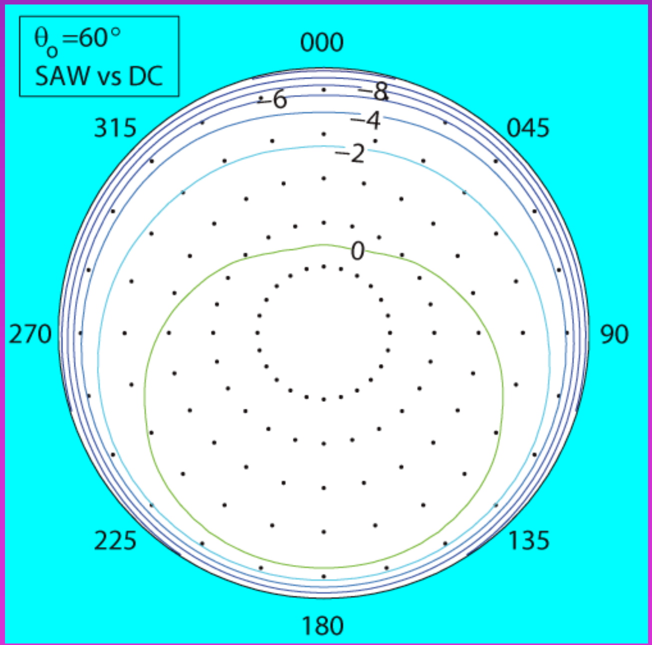


Model

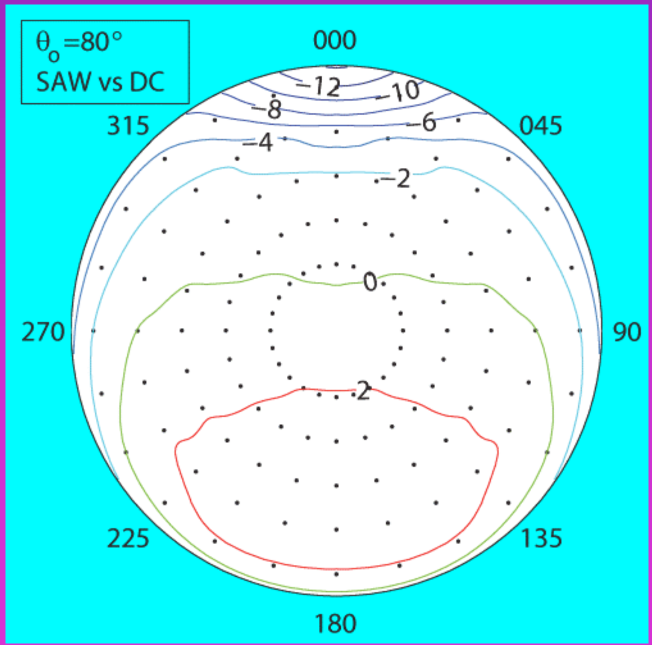
CERES – Model (%)

Effects of Atmospheric Variability on *R*

- The Dome-C and subarctic winter atmospheres are nearly the extreme cases for atmospheric conditions over permanent snow



α_{DC}=0.711, α_{SAW}=0.659

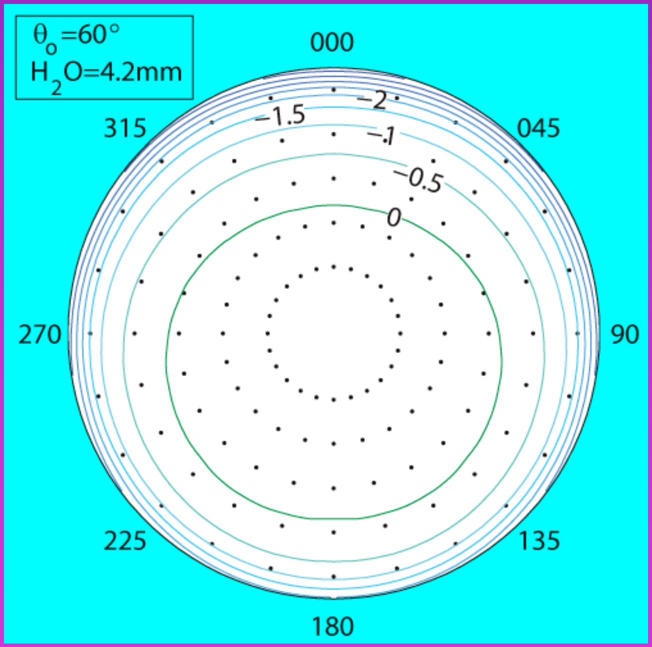


α_{DC}=0.717, α_{SAW}=0.641

Effects of Atmospheric Variability on *R*

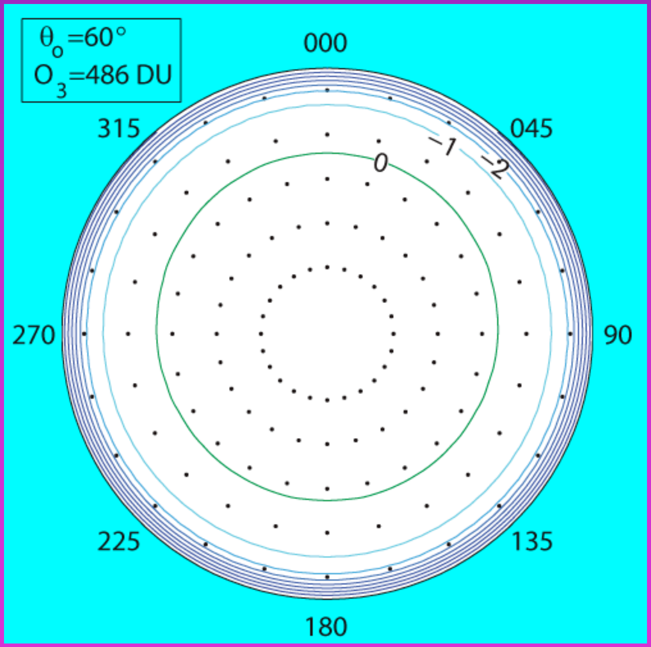
- Water vapor and ozone increases have similar effects on TOA *R*

Increase PWV from 0.7 to 4.2 mm



$\alpha_{0.7mm}$=0.711, $\alpha_{4.2mm}$=0.685

Increase O_3 from 284 to 486 DU

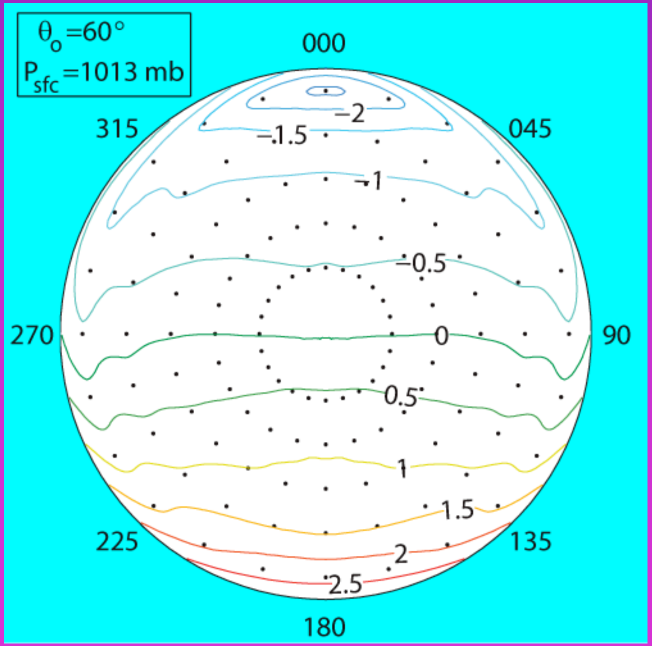


α_{284DU}=0.711, α_{486DU}=0.695

Effects of Atmospheric Variability on *R*

- Surface pressure (elevation) changes also change TOA *R*; change is larger, relative to albedo change

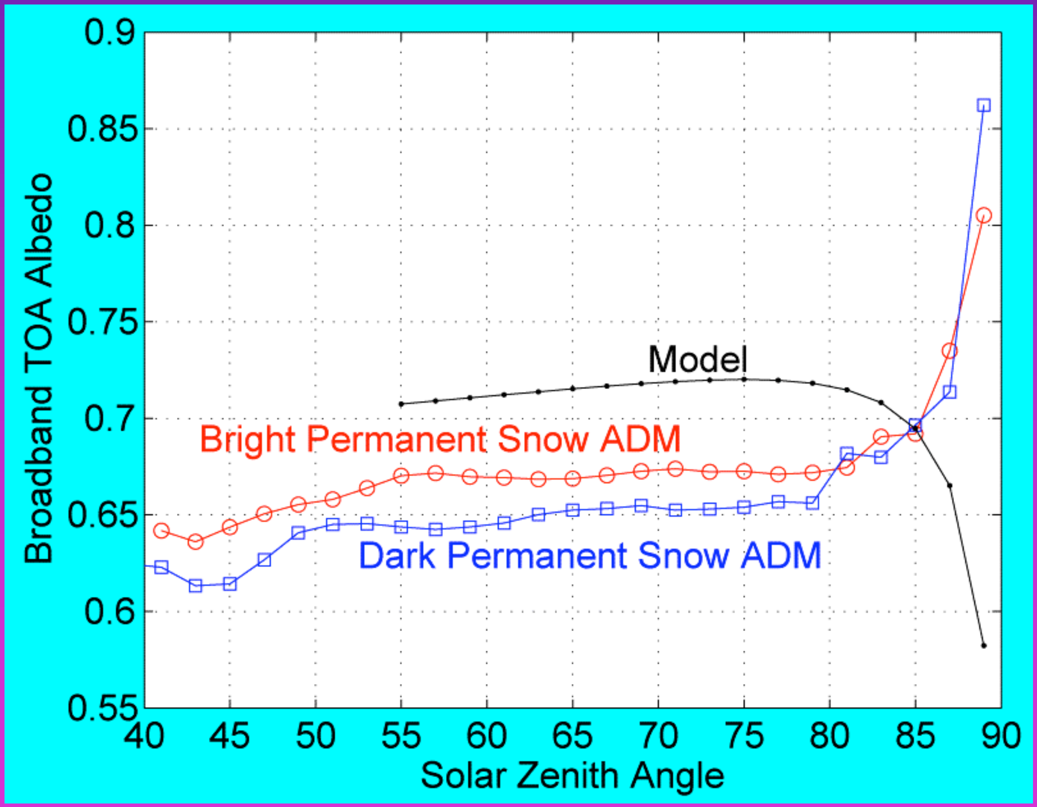
Increase P_{sfc} from 650 to 1013 mb



α_{650mb}=0.711, α_{1013mb}=0.702

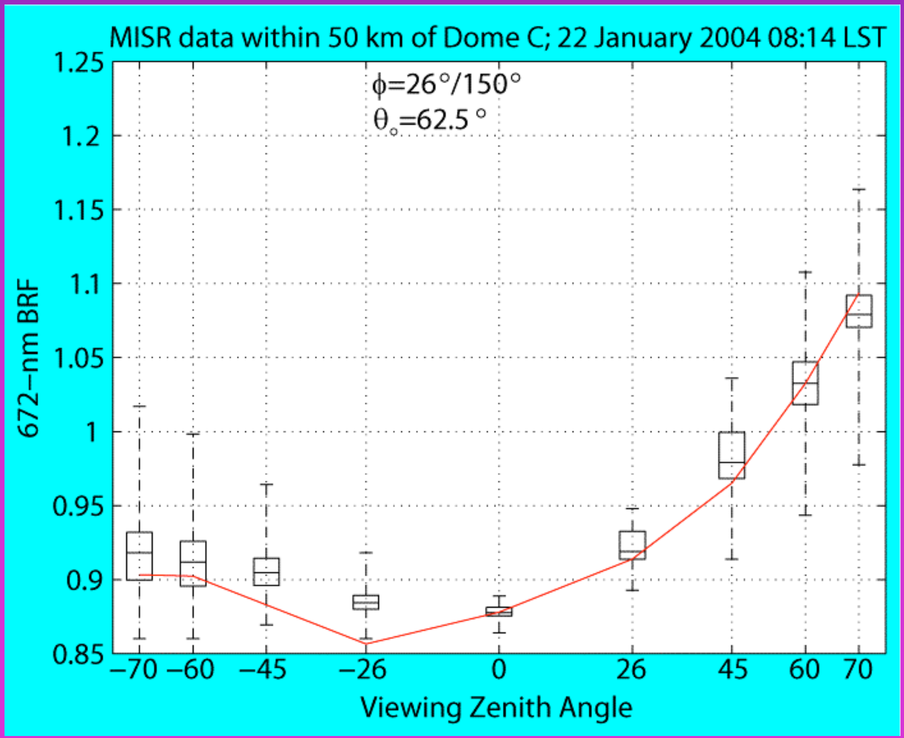
CERES and Modeled Albedo Comparison

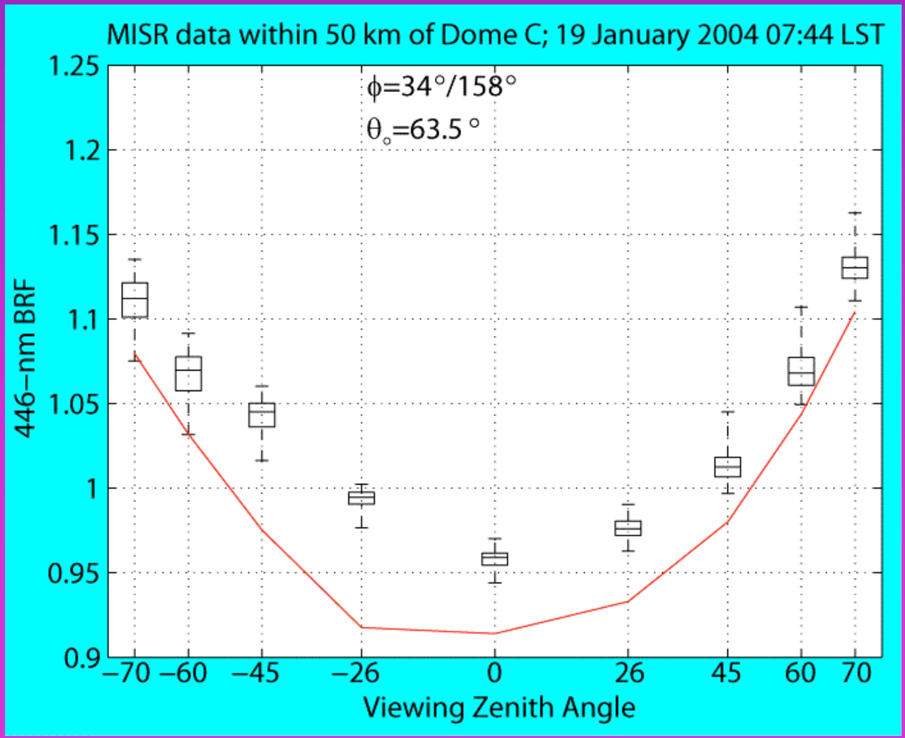
- Modeled albedos at TOA are larger by nearly 10% than the ADM albedos
- Some of this difference is expected since Dome C is higher and drier than many permanent snow regions



Is the Model Overestimating Reflectance?

- Comparisons of the modeled radiances with MISR observation suggest the model gives accurate or low estimates of radiance.





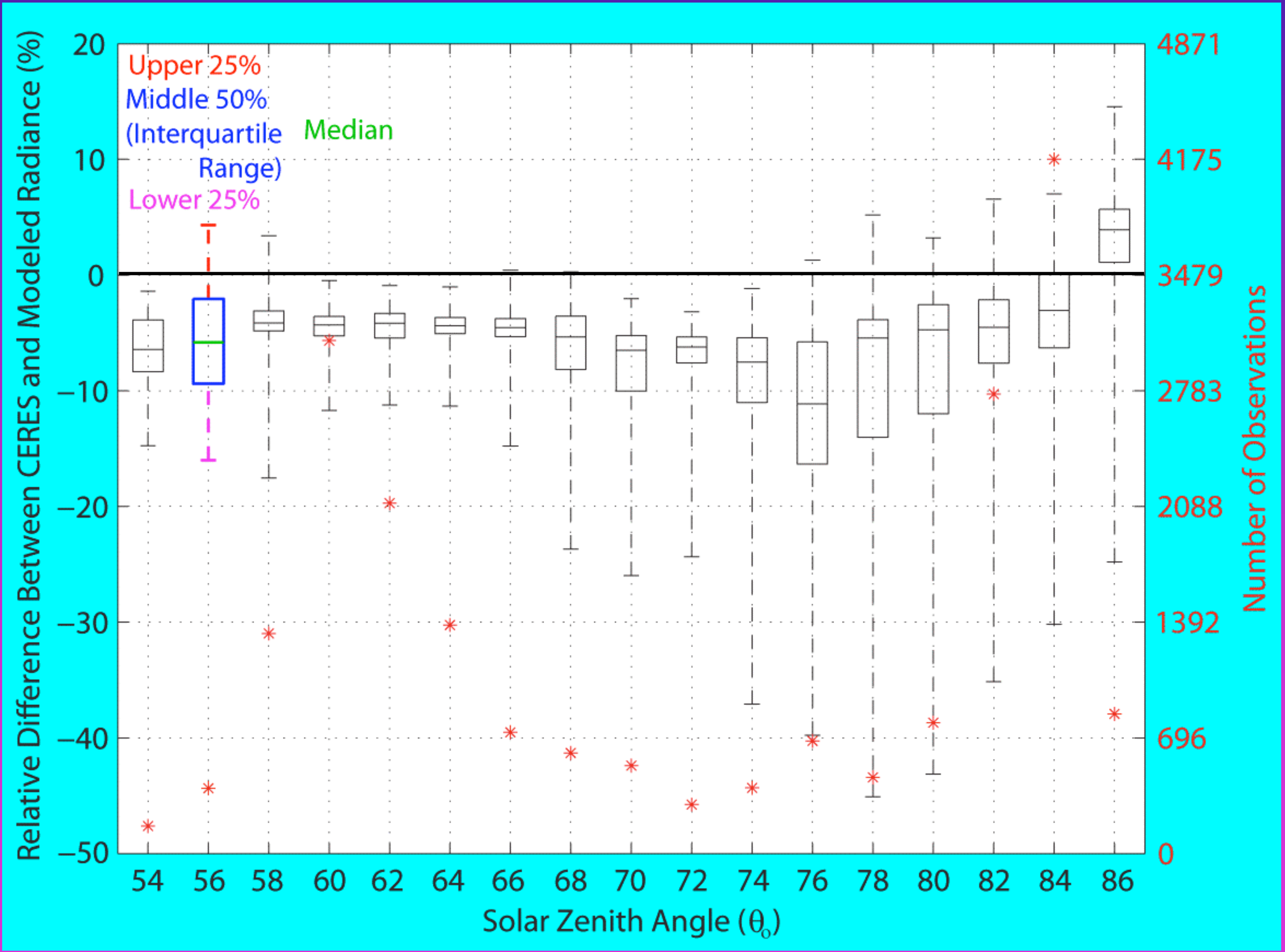
Conclusions

- The CERES permanent snow ADMs are representative of the Dome-C region
- Atmospheric variability over permanent snow regions can cause variations in R at the TOA of generally less than 2% at viewing zenith angles less than 70°

Conclusions

- The average albedo of permanent snow from the ADMs is too low for the Dome-C region
- Some of the albedo difference is due to the thin, dry atmosphere above Dome C
- Direct comparisons of radiance observations with the model show about a 4% bias, with CERES radiances less than modeled

Assessing CERES SW calibration



Possible explanations for CERES-Model radiance offset

A. Could measured surface albedo be unrepresentative;
higher than in CERES footprint?

1. The albedo was measured over a flat surface; albedo of rough surface is lower.
   Insignificant at Dome C (albedo difference 0.003)
   Bigger difference where sastrugi are larger, but blowing snow hides sastrugi

2. Soot contamination near the station?
   Error is in the wrong direction. Soot at station was 1- 7 ppb;
   in remote snow 0.2-0.7 ppb

3. Grain size smaller at measurement site?
   Would need r=300 μm
   Traverse showed no variation; grain radius 50-100 μm along route.

B. Could measured surface albedo be erroneously high?

1. Shadowing correction too large?

   Correction of 4% was obtained in two different ways.

   If correction were removed, albedo would be too low in visible by 0.04
   based on known absorption coefficient of ice.

   Correction was 1% at South Pole; gave same visible albedo.

2. Cosine-collector inaccuracy.

   Measurement was made under diffuse illumination; effect cancels.

   Multi-year albedos from pyranometer at South Pole have been corrected
   for deviations from "cosinicity"

3. Surface slope causes errors.

   No error under diffuse light.

   Dome-C region has slope <0.06 degrees

C. Modeling errors

1. Dependence of albedo on incidence angle

   Discrepancy with CERES is independent of solar zenith angle.

   Modeled surface albedo is actually too low for blue and UV because of old ice optical constants.

2. Atmospheric aerosols

   Adding stratospheric aerosol to model slightly increases computed TOA albedo.

3. Water-vapor and ozone column amounts

   Multiplying water-vapor by 6 would decrease TOA albedo by 3.6%.

   Doubling ozone would decrease TOA albedo by 3%.